



High Recoil Munitions Weapon Compatibility Issues & Shooter Effects

Presented To:
NDIA
Small Arms Conference

August 2001

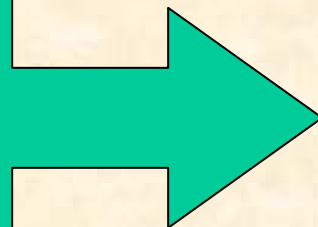
Michael Prussack
U.S. Army TACOM-ARDEC
AMSTA-AR-CCL-B, Bldg 65N
Picatinny Arsenal, NJ 07806-5000
(973) 724-2239
<michaelp@pica.army.mil>



High Recoil Munitions

Weapon Compatibility Issues & Shooter Effects

Recent Military
interest in Non Lethal
and Specialty
application
ammunition



Proliferation of
numerous new muzzle
launched and other
various systems which
generate high recoil





High Recoil Munitions Weapon Compatibility Issues & Shooter Effects

Recoil - Basic Physics

Recoil Impulse (RI) – Momentum of the “system”

RI = Weapon Mass x Maximum Weapon Velocity
(As measured on a free recoil pendulum mount)

Recoil Energy (RE)

$$RE = \frac{1}{2} MV^2$$



High Recoil Munitions

Weapon Compatibility Issues & Shooter Effects

Generally, under similar conditions, Higher Mass projectiles result in higher recoil observed by shooter

Example: For similar 5.56mm cartridge propellant loads, the following is observed (as fired from an M16A2) :

Projectile	Projectile Weight	Velocity	Recoil Energy
M855	0.009 lb (62 grains)	3000 f/s	3 ft lb
XM95 balls	0.6 lb	277 f/s	58 ft lb

Difference in systems results in a recoil energy difference of 19X



High Recoil Munitions Weapon Compatibility Issues & Shooter Effects

In addition to the newer Rifle Launched Systems, there are many other systems which possess high recoil characteristics.

- Past Development Programs (ARGM)
- Currently Fielded Systems
- Future Systems



High Recoil Munitions Weapon Compatibility Issues & Shooter Effects

RECOIL MEASUREMENTS – ASSORTED SYSTEMS

Ammunition	Weapon	Firing Impulse (lb s)	Recoil Energy (ft lb)
5.56mm, M855	M16A2	1.38	3.3
7.62mm, M118	M24 SWS	2.85	9.2
12 GA 2.75”- 00	Winchester 1200	3.52	28.0
40mm, M433 HEDP	M203 on M16A2	2.93	11.7
XM95 Non Lethal	M4 Carbine	5.92	69.2
XM95 Non Lethal	M16A2	5.82	57.8
RLEM (1 st design)	M16A2	7.45	101.6
RLEM (2 nd design)	M16A2	5.68	58.94



High Recoil Munitions Weapon Compatibility Issues & Shooter Effects

Issues related to high recoil in shoulder fired systems currently under development have seriously impacted the efforts to Type Classify these items.

- 5.56mm, XM95
- 5.56mm, RLEM

Shoulder fired systems under development in the recent past have also been impacted by recoil concerns

- ARGM



High Recoil Munitions Weapon Compatibility Issues & Shooter Effects

Potential Recoil Issues in Weapon System Development

- Safety Limits / Restrictions (60 ft lb limit)
- Damage to Weapon / Ancillary Equipment
- Potential Long Term Shooter Aiming Effects



High Recoil Munitions Weapon Compatibility Issues & Shooter Effects

5.56mm, XM95 Rifle Launched Non Lethal Mmunition

High recoil had significant impact on termination of initial SEP program for failure to meet user requirements

- Firing of XM95 munition damaged M203 mounting bracket on M16A2 and M4





High Recoil Munitions Weapon Compatibility Issues & Shooter Effects

XM95 Recoil Issues (cont.)

- When fired from M4, recoil exceeded the 60 ft lb limit
- When fired from the M16 or M16 with M203 or M4 equipped with the M203 the recoil is below, but near the recoil limit (shooter restricted to 25 rounds maximum per day)



High Recoil Munitions Weapon Compatibility Issues & Shooter Effects

Impact of XM95 recoil on Soldier Performance was studied by the Army Research Laboratory (ARL), Human Research Engineering Directorate (HRED).

- Purpose of the study was to investigate the ability of soldiers to effectively hit targets after firing the high recoil XM95 system.



1. Large male soldier - M16



2. Small female soldier - M16



3. Large male soldier - M4



4. Small female soldier - M4



XM95 Firings



High Recoil Munitions Weapon Compatibility Issues & Shooter Effects

5.56mm, Rifle Launched Entry Munition (RLEM)

High recoil of this system required significant re-design of system and slippage of milestones

- System recoil exceed 60 ft lb recoil limit
- Modifications have reduced recoil to acceptable levels



High Recoil Munitions Weapon Compatibility Issues & Shooter Effects

- For all current / future shoulder fired muzzle launched items, recoil will likely continue to be an issue.
- Recoil issues need to be addressed early on in the developmental cycle to avert costly program delays due to:

System modifications

Potential failures in meeting program requirements.



High Recoil Munitions Weapon Compatibility Issues & Shooter Effects

With all of the recent issues regarding high recoil in small arms weapon systems, established recoil limits have become a “hot” topic in the small arms community.

The current established limits are as follows:

- 60 ft lb - Maximum Recoil Limit - (DTC TOP 3-2-504)
- 45-60 ft lb - Soldier restricted to firing 25 rounds / day (TECP 700-700)



High Recoil Munitions

Weapon Compatibility Issues & Shooter Effects

- September 2000 – Edgewood Arsenal, MD
Small Arms community held Meeting to discuss recoil situation with regard to small arms weapon systems
- Where/Why did recoil limits originate ?
- Are they valid limits ?
- Were they based on actual physiological effects on humans ?
- Should we be basing our program decisions on these values ?
- Extensive Literature search conducted – nothing discovered
- Conclusion – All parties involved agreed that a scientific study is required to better define recoil limits



High Recoil Munitions Weapon Compatibility Issues & Shooter Effects

Ongoing / Future Actions Regarding Small Arms Recoil

- All involved parties agree on need to better define recoil parameters
- Project Officer has been assigned at Medical Research Materiel Command (MRMC) to investigate recoil “problem” – no official program has been initiated
- Veterans Administration (VA) Hospital, East Orange, NJ is capable of and has shown interest in conducting the required studies
- Need to identify funding source to conduct necessary studies. No single program can afford to fund this effort.



High Recoil Munitions Weapon Compatibility Issues & Shooter Effects

CONCLUSION

- Resolution of high recoil issues not likely to be resolved soon